^{161}Tb (30 MBq/nmol) and investigated in vitro using somatostatin receptor-positive AR42J rat tumor cells. Viability and survival assays were performed in vitro.
Results: In vivo application of ^{161}Tb-folate (10 MBq) resulted in a reduced KB tumor growth and, as a consequence, in an increased survival time (54 d) of mice compared to those treated with ^{177}Lu-folate (10 MBq, 35 d) [3]. Based on BUN and creatinine plasma values and histological investigations of renal tissues, ^{161}Tb-folate did not result in more severe damage to the kidneys than ^{177}Lu-folate, however. In vitro investigations with ^{161}Tb-DOTATOC and ^{161}Tb-DOTATOC-NLS revealed comparable uptake into AR42J cells, but externalization of ^{161}Tb-DOTATOC-NLS was lower (~25%) than for ^{161}Tb-DOTATOC (~55%) after 6 h. After 2 h of incubation the fraction of internalized ^{161}Tb-DOTATOC-NLS, which was localized in the nucleus (~3%), was significantly higher than the fraction of ^{161}Tb-DOTATOC (<0.5%). AR42J cell killing after application of ^{161}Tb-DOTATOC-NLS was more effective (IC50 ~1.5 MBq/mL) than after treatment with ^{161}Tb-DOTATOC (IC50 ~8 MBq/mL).
Conclusion: Due to additional Auger electron emission, ^{161}Tb appears to be more effective for tumor treatment than ^{177}Lu. The effect caused by Auger electrons was found to be more powerful if the radioconjugate targets the cellular nucleus by means of a NLS. Interestingly, kidney damage was not enhanced after therapy with ^{161}Tb compared to the treatment with ^{177}Lu. Based on these findings, ^{161}Tb has a great potential to be used in future clinical practice as it may kill single cancer cells and cell clusters more efficiently than ^{177}Lu without causing additional side effects.

Keywords: ^{161}Tb, Auger electron, nuclear localizing signal

References:
[1] Müller et al. 2013 J Nucl Med 1:124-131.
[2] Haller et al. 2015 Nucl Med Biol 42:770-779
[3] Müller et al. 2014 Eur J Nucl Med Mol Imaging 41:476-485.

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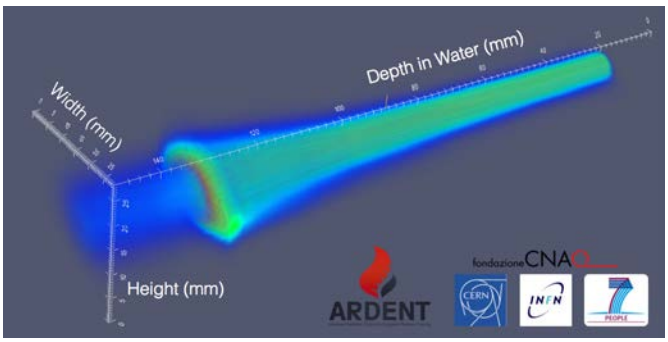
The GEMPIX detector for energy deposition measurements in Hadrontherapy
F. Murtas[1,2], M. Ciocca[3], S.P.George[1], A.Mirandola[3], A. Rimoldi[4], M. Silari[1], A. Tamborini[4]
[1] CERN
[2] LNF-INFN
[3] Centro Nazionale di Adroterapia Oncologica
[4] University of Pavia & INFN

A triple GEM detector with a 55 μm pitch pixelated ASIC for the readout has been used at CNAO in Pavia for a detailed measurements of energy deposition inside a water phantom. The detector was operated with a gas mixture of Ar CO_2 CF_4 at a moderate gain and the measurements were performed with a beam of 120 MeV protons and 330 MeV/u Carbon ions. The energy deposition was measured at different positions in depth allowing a 3D reconstruction of the beam inside the phantom as shown in the figure. A small number of single event upsets in the pixel readout appear only in the Bragg peak and the DAQ can recover them for each acquisition. A detailed simulation was performed with GEANT4 and it was found in good agreement with the experimental data.
The future uses and upgrade of this device, including its potential application in microdosimetry, are discussed.



Keywords: GEM Detector, Timepix readout, Hadrontherapy

References:
[1] F.Murtas, Applications of triple GEM detectors beyond particle and nuclear physics, 2014 JINST 9 C01058
[2] S. P. George et al., Particle Tracking with a Timepix Based Triple GEM Detector, 2015 JINST_024P_0615
[3] P. Piersimoni et al., Optimization of a general-purpose, actively scanned proton beamline for ocular treatments: Geant4 simulations, Journal of applied clinical medical physics, volume 16, number 2, 2015

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OPEN-MED: LEIR Based biomedical infrastructure @ CERN
M. Baumann[1,2,3,4], P. Lambin[5], S. Myers[6], G. Roy[6], M. Waligorski[7,8]
[1] OncoRay – National Center for Radiation Research in Oncology, Faculty of Medicine and University Hospital Carl Gustav Carus, Technische Universität Dresden, Helmholtz-Zentrum Dresden – Rossendorf, Dresden, Germany
[2] Department of Radiation Oncology, Faculty of Medicine and University Hospital Carl Gustav Carus, Technische Universität Dresden, Dresden, Germany
[3] Helmholtz-Zentrum Dresden - Rossendorf, Institute of Radiooncology, Dresden, Germany
[4] German Cancer Consortium (DKTK), Dresden and German Cancer Research Center (DKFZ), Heidelberg, Germany
[5] Maastro Clinic, Maastricht, The Netherlands
[6] CERN
[7] Institute of Nuclear Physics PAN, Radzikowskiego 152, 31-342 Krakow Poland
[8] Centre of Oncology (COOK), Garncarska 11, 31-115 Krakow Poland

The need for an open-access biomedical research facility was first raised by the scientific community at the 2010 Physics for Health workshop, where CERN was asked to take the lead on this initiative.
In 2012, a brainstorming meeting evaluated the possibility of modifying the existing CERN Low Energy Ion Ring (LEIR) accelerator to establish such an infrastructure. The medical and radiobiological communities united in broad agreement on the need for such a dedicated research facility.
The Biomedical facility at CERN (OPEN-MED) would create an open collaborative biomedical research infrastructure. By sharing the facility internationally, more rapid progress can be made by:

- Complementary collaboration with leading universities, research facilities and industry
- Comprehensively investigate complex physical and biological parameters that control radiation cell killing efficiency under highly controlled conditions.
- Provide accurate data for the modelling of radiation effects for proton and ion beam clinical applications
- Study comparative beam ballistics and dosimetry in phantoms and so improve predicted physical dose distributions.
- Provide a range of beams and infrastructure for developing new instrumentation for detection and imaging.
- Provide adequate beam time